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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Evaluation of Ball and Roller Bearing Greases

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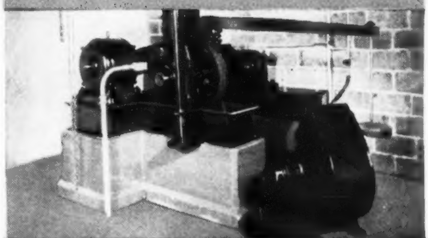

DUPLICATING ACTUAL OPERATING CONDITIONS, machines like this grease tester put new products through their paces before they ever come out of the Texaco Laboratory.

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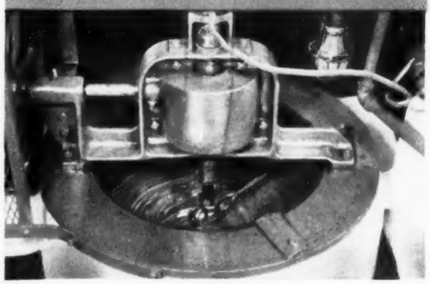

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LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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The Texas Company, 135 East 42nd Street, New York City

Vol. XXVI December, 1940 No. 12

Evaluation of Ball and Roller Bearing Greases

WHEN the Annular Bearing Engineers Committee began to function actively some years ago after perhaps a decade of individual study by ball and roller bearing engineers and the research personnel of a few of the large oil companies, evaluation of ball and roller bearing greases became one of the most important problems in these industries. Undertaken on a cooperative basis, for the purpose of proving or disproving certain rule of thumb theories, this activity quickly led to the development of several unique laboratory devices.

Some of these had been already existent in principle, but required perfecting. Others were comparatively new. The idea back of all, however, was to observe bearing lubricant performance under simulated operating conditions which could be varied to include extremes of temperature, and representative speeds and pressures.

Relation of Sealing

These laboratory activities were accompanied by more serious consideration of methods of sealing and study of lubricant performance under subnormal or abnormal temperature conditions. Ball and roller bearing sealing was not a new idea, but control of the lubricant in the bearing came to be considered as most important.

With the development of pressure grease lubrication, a most disturbing habit became evident among many plant operators. The grease gun gave them a means for protecting their bearing investment, and they literally "fell over backwards" in their endeavor. The result was that greasing schedules were sometimes planned as often as twice daily.

Few, however, seemed to realize that for each gram of fresh grease applied, almost an equal amount of used grease had to go somewhere—usually past the bearing seals to accumulate or drip onto adjacent parts of the machine. This was often aggravated when the bearing was subjected to higher temperatures, especially when greases were used which would thin down to a virtual "light oil" state of fluidity. Under such conditions increase in temperature would have a contributing effect to leakage similar to the effect resulting from applying grease to the bearing under sufficient pressure to force it past the seal.

It doesn't take much pressure to impair the sealing properties of many excellent bearing seals. Once this has occurred, more frequent re-lubrication becomes a virtual necessity. So, many bearing authorities began to refrain from using pressure gun fittings in favor of plugs which could be installed only when it was time to re-lubricate. This stymied the over-zealous custodian of the grease gun; it also reduced cost of lubrication and improved bearing performance, for a ball or roller bearing is a unique device which functions best on a minimum rather than an excess of grease.

With this accomplished, bearing designers could then give even more careful attention to their sealing methods. The logical result was the prepacked double-seal bearing and the

cartridge type unit which today are designed to operate for several years on the initial charge of grease, which in a small bearing may be as low as one gram in weight.

GREASE RESEARCH

Meanwhile, the petroleum industry inaugurated a most extensive grease research program. Better sealing required better lubricants, meaning that greater durability was necessary.

The durability of a grease is synonymous with its lubricating ability; any change in the physical or chemical nature which will affect this is objectionable. The physical nature of a ball or roller bearing grease is most apt to be affected by temperature or moisture; the chemical nature by oxidation of certain of its petroleum or fatty oil components.

Temperature affects the consistency inversely. In other words, the grease gets harder as the temperature goes down, and softens at higher temperatures. Within certain reasonable limits, this has comparatively little effect upon the lubricating value. To be sure, relubrication at low temperatures may be more difficult, some grease guns being unable to pump certain greases. Conversely, as the higher temperature limits are approached, leakage may develop, but this is not likely if the grease is specifically prepared for ball and roller bearings and the seals are effective.

Temperature Research

As industrial ball and roller bearings are more apt to be exposed to high temperatures rather than to chilling, it was logical to design such equipment as the A.B.E.C. machine so that grease behavior at certain elevated temperatures could be observed, up to a reasonable limit, such as 220 degrees Fahr. (though a maximum of 300 degrees Fahr., is attainable). In addition to the leakage tendencies, it is also practicable to observe the torque characteristics as well as the ability of the grease to adhere to the test bearing at the temperatures of test, which are normally 80, 150, and 220 degrees Fahr.

The same observations are practicable with the torque-breakdown machine of The Texas Company as shown on page 137. This device, however, is possessed of an advantage in that three speeds are available, i.e., the conventional 1750 r.p.m. motor speed, as well as lower speeds of 900 and 36 r.p.m.

In addition, both high and low temperature conditions can be simulated as the device is provided with an insulated chamber equipped with copper tubing, permitting the circulation of brine or steam, there-by affording a temperature range from minus 40 to 350 degrees Fahr., or above. The bearing and housing are located in the aforesaid chamber which is capped with an insulated cover plate during the test procedure.

It is also practicable to carry out low temperature torque tests on either ball or roller bearings in a cold box or cold room wherein the temperature of observation is contingent upon the refrigerant used. By designing a suitable turning mechanism, certain investigators have developed a cold box test whereby it is practicable to measure the time required to make one or more complete turns of the bearing. This is expected to afford an interesting means whereby low temperature starting characteristics of certain greases can be further evaluated in terms of the time required to turn the test bearings. (See pp. 138–139.)

Low temperature evaluation of ball and roller bearing greases occupies a most important part in grease research today in view of advances made in aviation. The modern aeroplane has gone practically entirely to the ball bearing. Few realize the multitude of such bearings required for control mechanisms, landing gear, and engine accessories on the transport or military ship today. A safe estimate is from 1000 to 1500 bearings, all of which must function at whatever atmospheric temperature the plane may encounter. From 40 degrees Fahr., below zero to 150 degrees Fahr., is the temperature range over which lubricants for control bearings are expected to function; on the other hand, magneto and generator bearings must be lubricated at temperatures as high as 350 degrees Fahr.

This presents an entirely new problem to the grease chemist; for, in addition to the relative viscosity and pour test ranges of paraffin and naphthenic base oils, he must consider their compounding ability with a wide variety of fats, the oxidation tendencies of these latter, and the metallic bases available for soap formation. Suitable laboratory testing equipment is of inestimable value in enabling him to evaluate his proposed compounds. Laboratory testing in terms of days must literally predict bearing performance in terms of years.

The Effect of Moisture

Moisture, in turn, may cause change in a grease if the soap constituent is affected. Lime soaps are conventionally thought of as relatively insoluble in water, whereas sodium soaps may be affected, dependent upon the nature of the fat used in their manufacture. But sodium soap greases withstand higher temperatures; so, even though they may be soluble, they are preferred alone or in combination with a small percentage of lime soap for many types of ball or roller bearing lubrication.

Chemical Breakdown

Another most active phase in research during latter years has been the development of practicable laboratory tests which will predict grease performance in service. In other words, the grease chemist has realized that oxidation is the primary reaction which may change the chemical nature of a grease. Long time storage tests of bearings packed with various greases have been popular in the bearing industry and grease laboratories for years. They have foretold some valuable data as to grease compounding, but the fact that one had to wait for months and even years to be sure was a definite objection. So, accelerated oxidation was studied.

This has been approached from two angles:

The static, whereby test samples of greases in suitable containers are exposed to oxygen under controlled pressure and temperature, and

The dynamic, whereby exposure of fresh surfaces of the grease prevails. Operating a bearing in an atmosphere of oxygen was one angle of approach. It is still being studied.

RESISTANCE TO FLOW

The various torque and breakdown machines discussed elsewhere in this article indicate the relative change in fluidity which will occur in a grease when subjected to agitation in a ball bearing, also the effect of temperature. In addition, it is of interest to note certain observations of investigators who have studied this change in plasticity from the viewpoint of viscosity, especially where pressure prevails.

There is a direct relation between the rate of change in physical characteristics of a grease with temperature or pressure and its performance in service. Change in consistency which would be comparable with change in viscosity in an oil has prompted a number of investigators to attempt to develop a method of determining the viscosity of greases or their resistance to flow, as a guide to prediction of the temperature range over which any such product should be used, and the relation of torque, or power consumption, through internal friction.

The research work of Dr. E. C. Bingham and M.H. Averson in the study of viscosity determination of very viscous substances such as greases, and the design of actual equipment for such measurements is particularly noteworthy. Both employed pressure for the acceleration of the flow of material through their respective machines. In this regard, Dr. Bingham found that "in the measurement of plasticity . . . high pressures give data which may be handled more simply than the data at low pressures."†

Arveson*, in turn, showed that the apparent viscosity of a grease varies with the rate of shear and that it may be accurately measured in a constant shear viscosimeter.

Other investigators, such as Herschel‡, Bulkley and Bitner§, have worked towards a type of consistometer which will enable one to work out flow-pressure diagrams. The latter hold a particular advantage for this type of machine in the study of materials which change rapidly in consistency with time, or which show a breakdown of structure with mechanical working.

Any device for determination of change in consistency or viscosity with pressure or temperature involves a static test. In realization of this fact, there has been an interesting trend among still other practical investigators toward development of a testing machine which will enable visual observation of the behavior of a grease under actual service conditions. Details of some of the most informative machines for the study of breakdown tendency and torque, or power consumption, in grease lubricated ball or roller bearings are discussed elsewhere in this article. Likewise, a composite machine has been built, which enables these observations to be obtained simultaneously, with suitable data for plotting of torque curves for any comparatively plastic grease, in terms of gram-centimeters. These data are obtainable under service temperature conditions.

Actual service tests on greases especially devised for ball and roller bearing lubrication have shown a most interesting agreement with the data and observations made on the same products on the so-called Torque-Breakdown Machine. They have proved conclusively the value of correlating laboratory research with practical service in the study of refinery practices incident to manufacture of specialty greases and other lubricants designed for intensive duty.

In the study of torque characteristics of various types of grease, the data developed by this Torque-Breakdown Machine have checked with Arveson's statement that "While the initial torque of ball bearings freshly filled with the proper grease was dependent upon the consistency . . . in other words, on apparent viscosity at low rates of shear . . . the torque and rise in temperature at equilibrium conditions were primarily dependent upon the viscosity of the oil in the grease."* Later research has proved, in addition, that torque is also materially affected by the method of manufacture.

†E. C. Bingham, "Fluidity and Plasticity," pp. 77-78, 320-323, McGraw-Hill Book Company, 1922.

*M. H. Arveson, Oil and Gas Journal, March 31, 1932, pp. 96, 167.

‡W. H. Herschel, Journal of Rheology, Oct., 1929, pp. 68-75.

§R. Bulkley and F. G. Bitner, Bureau of Standards Journal of Research, Vol. No. 5, pp. 83-96.

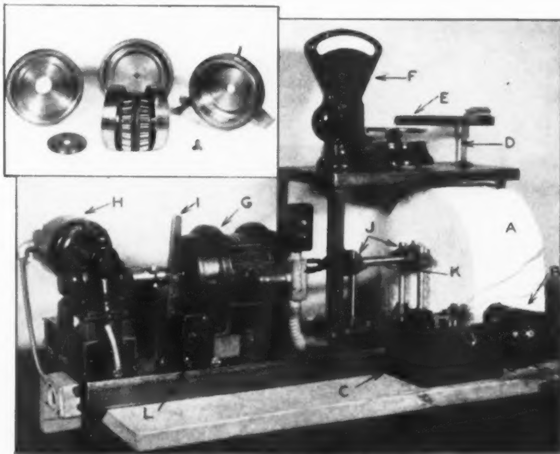
Grease Evaluation at Elevated Temperatures

The Texas Company Machine

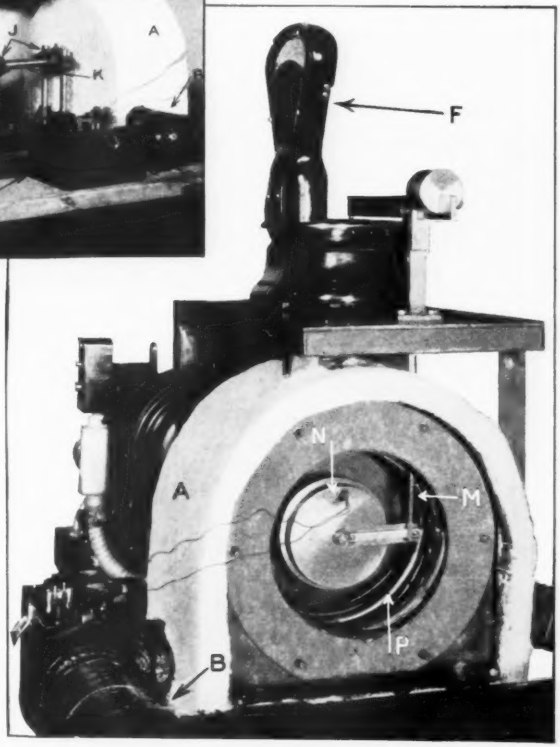
The A. B. E. C. Machine

Both of the above machines are designed for observing grease performance in ball bearings. In design, each involves a fractional H.P. Motor attached directly to a shaft carrying a ball bearing. By enclosing this latter in an oil jacketed housing which is subject to temperature control (electric for The Texas Co., and gas for the A. B. E. C. machine), it is practicable to observe grease behavior, as to aeration, leakage, channeling, or change in texture over a wide temperature range up to a maximum of 300 degrees Fahr. The A. B. E. C. machine includes a mechanism for measuring both starting and running torques.

After a test the bearing can be removed, cooled and studied for grease leakage, as an indication of lubricant consumption. After complete cooling, the grease remaining on the bearing can be observed as to change in texture as compared with the original product.



Grease Testing by the Torque-Breakdown Machine

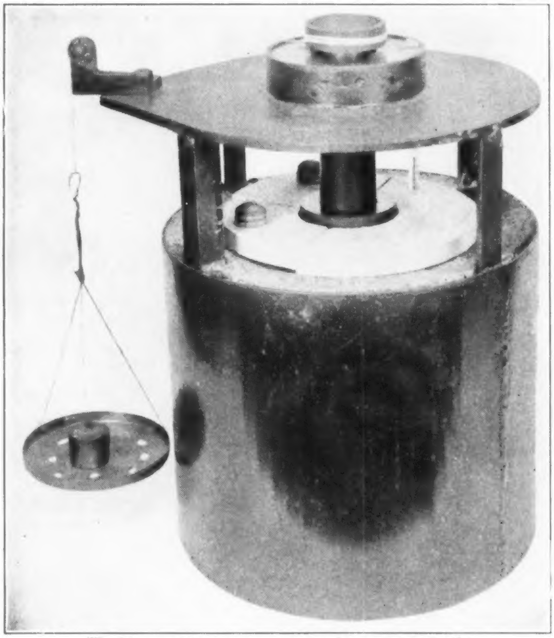


By testing a grease directly in a ball or roller bearing under controlled conditions as to speed and temperature, it is practicable to simulate actual service operation and obtain interesting information as to the behavior of any such type of lubricant. The torque-breakdown machine, illustrated here, consists of:

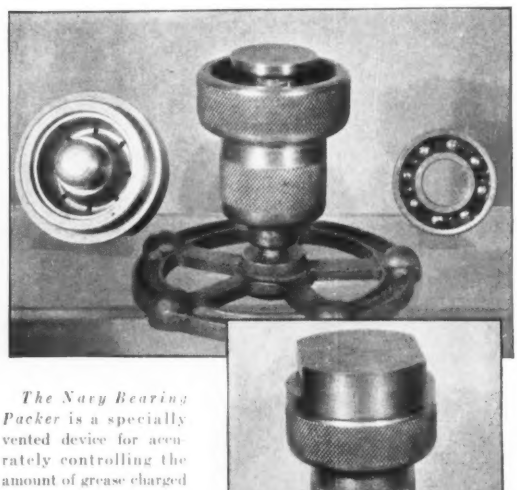
- A. An insulated jacket for controlling temperature of test. Test bearing is attached to end of shaft K.
- B. $\frac{1}{4}''$ line leading to inside of jacket. This carries either steam or cold brine.
- C. Potentiometer for obtaining temperature of outer bearing race.
- D. & E. Levers for transposing torque forces onto platform of gram scale, F.
- G. 1750 r.p.m., one h.p. induction motor, directly connected to shaft K.
- H. 900 r.p.m., $\frac{3}{4}$ h.p. induction motor which can be geared down to obtain shaft speed of 36 r.p.m. when necessary.
- I. Clutch lever for driving with either 1750, 900 or 36 r.p.m. Motor H drives through motor G.
- J. Shaft hangers.
- L. Motor starting switches.
- M. The system of levers (within A) for registering the turning moment of the bearing housing and transmitting it for registering in grams on the platform scale.
- N. The calibrated thermocouple for bearing temperature measurement.
- P. A series of copper tubing for circulation of refrigerant or steam within insulated jacket A.

By the use of this machine (developed by the Research Laboratories of The Texas Company), it is practicable to observe relative starting and running torques, leakage, and temperature rise caused by internal friction in the grease.

Note breakdown of a typical roller bearing assembly (in upper left hand corner). This shows the housing in which the bearing is located for test, to study effect of temperature on grease leakage; the torque characteristics and adherence of grease to the bearing. These observations are practicable on either ball or roller bearing over a temperature range from —40 degrees Fahr. to 350 degrees Fahr.



The Navy cold test apparatus, as shown above, is of the single spindle type with provision for liquid bath cooling.



The Navy Bearing Packer is a specially vented device for accurately controlling the amount of grease charged to a test bearing. Note the device completely assembled; also vented screw down cap, a typical test bearing and the base with provision for putting pressure on the grease to fill the bearing.

Showing the Navy Cold Test apar
Norma-Hoffmann Cold Testin Un
machines have been designed tes
greases at sub-zero temperatu s f
evaluating their low temperat e st
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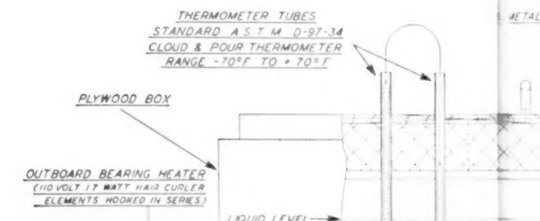
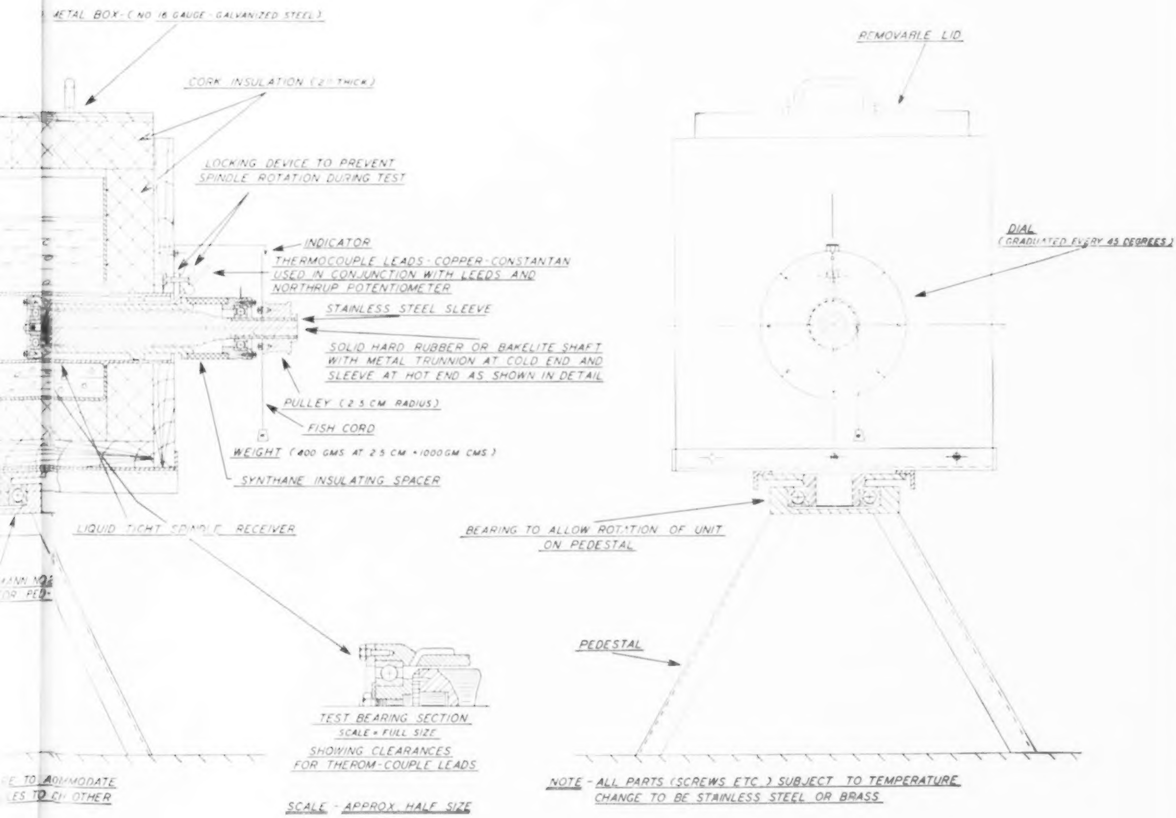


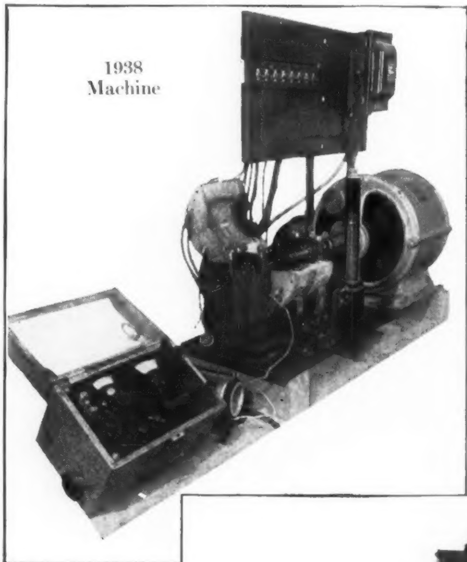
Cold Testing Units

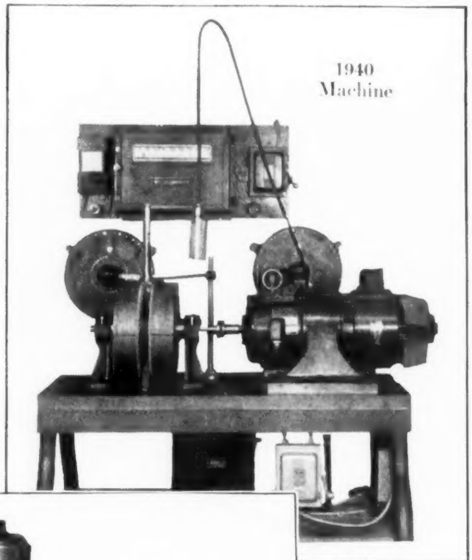
Test [a]pparatus (left) and the Testi[ng] Unit (below). These ...ned [f]... testing of ball bearing ...perat[ur]es for the purpose of ...perat[ur]e starting characteris... ...ann [ma]chine is an adaptation ...by th[e] General Electric Com... ...val [En]gineering Experiment ...Norm[a]-Hoffmann, greases for ...40 de[gr]ees Fahr., in a 204 ball ...illed [t]o approximately 10 per ...invol[ve]s about 0.7 grams of ...o th[e b]earing to insure of re-

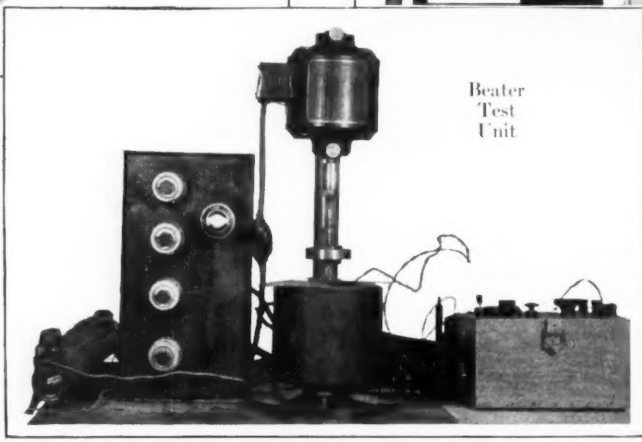
The test consists of determining the load in grams which must be applied to the bearing to start rotation, and the length of time required to bring about one complete revolution. An initial load of 500 grams is employed; if this fails to initiate any movement in the bearing, the load is increased to 1,000 grams and if necessary to 2,000 grams. The details of the Norma-Hoffmann machine show a circular disk mounted on the end of the bearing spindle which disk is divided into eight equal divisions around its circumference. After enough weight has been applied to start rotation, the time in seconds required for each division to pass a fixed point is observed. Also the total time to make one revolution under a given load is recorded.



U. S. N. Research


1938 Machine


1940 Machine


Beater Test Unit

The activity of the U. S. Naval Engineering Experiment Station at Annapolis, Maryland, in studying high temperature resisting greases is particularly noteworthy. This was prompted by the necessity for evaluating greases as to their suitability for mechanisms where temperatures approaching 350 degrees Fahr. and speeds around 2400 r.p.m. may prevail.

For test purposes, Navy Grease Machine 1938 was developed. It consists of a ball bearing mounted on a horizontal motor-driven shaft, surrounded by a housing and jacketing arrangement equipped for electric heat control. Test runs are made at constant elevated temperatures from 100 to 350 degrees Fahr., readings being taken from a thermocouple attached to the bearing. Provision is also available for measuring starting and running torques similar to the A.B.E.C. Machine.

Procedure

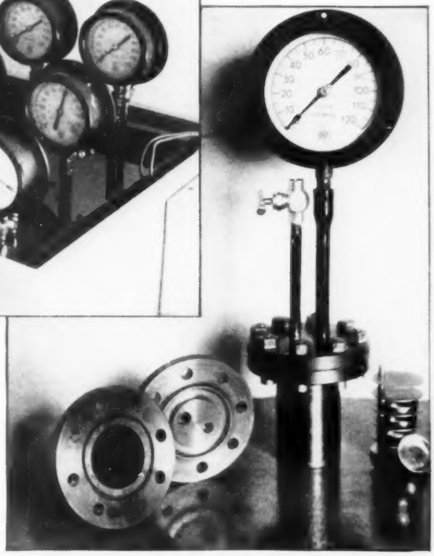
The bearing is charged for test by means of a special vented device (The Navy Bearing Packer), see p. 138, so that an accurately measured amount of grease is always used, and all voids in the bearing are filled with grease. One hour initial runs are made at 100 degrees Fahr. and 600 r.p.m., and at 350 degrees Fahr. and 2500 r.p.m., using a fresh charge of grease for each.

The Beater Test

Coincident with this test, a high temperature beater has been developed wherein the same grease is run for seven hours at 400 degrees Fahr. The beater involves an electrically heated jacketed receptacle holding about one-half pound of grease, which is so designed that a ball bearing mounted on a vertical motor-driven shaft can be immersed and rotated in the test sample. A wing nut which secures the bearing at the end of the shaft acts as a propeller to circulate the molten grease.

After running a grease in the beater as indicated, it is cooled and then samples thereof are in turn run in the Navy Grease Machine. Observation of the resultant starting and running torques, as well as any leakage, and comparison with similar observations gained from running the grease before beating, gives an interesting idea as to the effect of high temperature beating. Widely varying results are considered unfavorable to the grease being evaluated.

Since the development of Navy Grease Machine 1938 certain modifications have been included in Navy Grease Machine 1940 which is now in use at the Naval Engineering Experiment Station, supplementing and partially supplanting the 1938 machine. The principal modification in the 1940 machine is provision whereby the test bearing may be loaded up to its rated maximum load without interference with torque measurements. The accompanying illustration of the 1940 machine shows a front view with test weights in place.



The Norma-Hoffmann Stability Test

This is a static test for study of accelerated oxidation of greases. It is based upon the fact that oxidation of petroleum products, fatty oils, and lubricating greases, usually occurs in two stages. Norma-Hoffmann Bearings Corp. have done some interesting work in studying this type of oxidation, through the cooperative efforts of Messrs. F. L. Wright, H. A. Mills and W. A. Lutz in papers on "Some Applications of an Accelerated Test for Determining the Chemical Stability of Lubricating Greases,"* and "An Accelerated Oxidation Test for Chemical Stability of Lubricating Greases."** In principle, they have developed a mechanism which measures the rate at which oxygen is absorbed in oxidizing the readily oxidizable constituents in the grease sample. As two stages of oxidation are involved, they have termed the first step the "induction period." During this period a comparatively slow reaction rate occurs with relatively slight changes in the chemical properties of the materials under test. With many greases there is a sharp change in this rate of oxidation, indicated by a definite increase in the reaction rate. This point is regarded as the end of the induction period and the beginning of the second period. One is most concerned with the length of time involved during the induction period, as this is indicative of the stability of the grease under test.

The apparatus consists of a stainless steel bomb and a suitable constant temperature bath. For convenience, this bath is made large enough to hold several bombs. The bomb is fitted with a suitable valve for flushing and filling with oxygen, and is equipped with a pressure gauge to indicate drop in pressure resulting from the absorption of oxygen by the sample of grease that is put in the bomb. Grease samples weighing 20.00 ± 0.01 grams are spread in a uniform layer, over the surface of containers of glass or metal similar to that which is likely to contact the grease in actual service. The cups holding the grease samples are suspended on 18-8 stainless steel holders. Closure of the bomb is effected by bolting down the cover plate, a lead gasketed tongue and groove joint assuring pressure tightness.

When the bomb has been assembled for testing it is flushed by filling with oxygen and allowing the oxygen to escape. This is done at least five times, after which the bombs are filled with oxygen to approximate the pressure to be used, making allowance for the pressure increase that will occur when the bomb is heated to the testing temperature of 175 or 210 degrees Fahr. The bomb is then immersed in the constant temperature oil bath which is provided with agitation, and is thermostatically controlled to maintain the temperature within plus or minus 0.5 degrees Fahr., of the desired figure. When the bomb reaches constant temperature, usually within two hours, the oxygen is gassed off to the exact pressure selected for the start of the run, usually 110 pounds gauge.

During the test the pressures are recorded every two hours. These are plotted against time, either on standard coordinate paper or on logarithmic paper. A sharp break in the time-absorption curve indicates the end of the induction period.

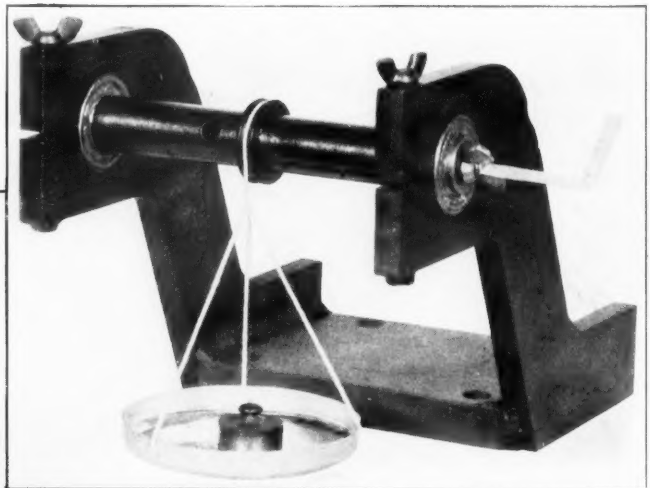
Some of the factors found to have an effect on the oxidation of grease when tested by means of the accelerated oxygen absorption method are oxygen concentration, the temperature at which the oxidation test is run, and the catalytic agents present in the form of metals in contact with the grease.

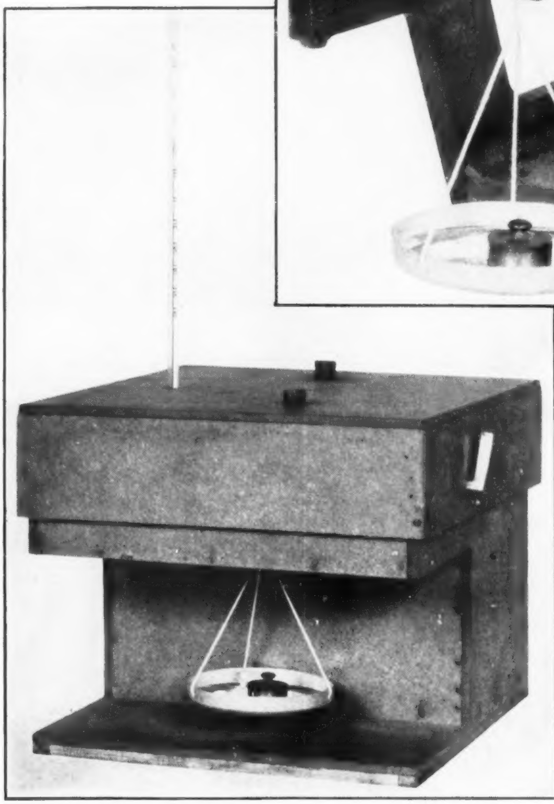
One which is satisfactory for ball and roller bearing lubrication will show no noticeable change in color, consistency, or appearance until the end of the induction period is approached, nor will there be any decided increase in acidity. After the grease begins to absorb oxygen more rapidly, however, it will quickly darken, turn rancid, perhaps separate oil, and show a decided increase in acidity.

* See proceedings of the American Society for Testing Materials, Vol. 38, Part II, 1938.

** A paper prepared for The Bearing Engineers Committee on lubrication.

The General Electric Method of Evaluating Greases*





In the evolution of The G. E. Study of the service properties of greases, oxidation tendencies were first measured by observing the increase in acidity after thin layers of the grease under test had been exposed to heat, light, and oxygen. This is regarded as a static test. Later a method more comparable to storage conditions was developed, involving the packing of conventional ball bearings with grease, following which they are exposed to oxidizing conditions, after which their resistance to turning can be noted. The latest method measures this latter before and after exposure to these conditions. Obviously, this is also a method of determining the starting torque.

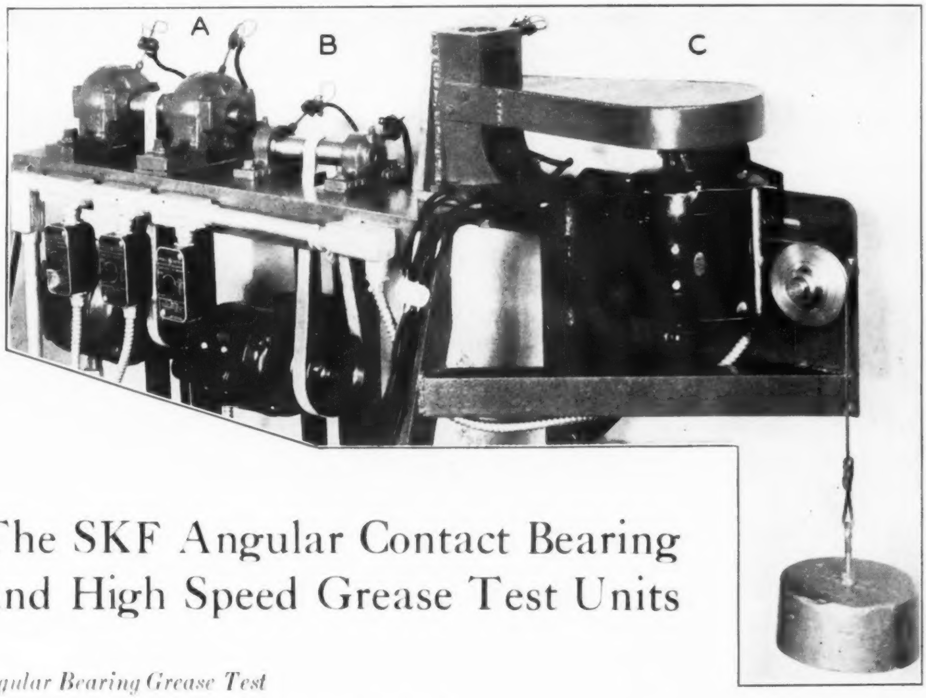
This test subjects the bearings and lubricants to the combined action of heat, light, oxygen, and moisture for a period of two weeks. In this the test differs from other accelerated oxidation tests in that pressure is absent, light and moisture being present instead. The author* regards light as particularly important, as the action thereof has been found to speed up the oxidation reaction materially.

Following the oxidation treatment, the bearings are again studied to determine the resistance to turning which the grease may impose. Any increase over the original force required for such turning is regarded as due to gummy or oxidized materials which have been developed within the grease in the bearing. The greater this force (or weight necessary to turn the bearing) the less resistant the grease is to oxidation in the opinion of the author.

The effect of bearing materials can also be judged. In other words, the test is regarded as showing the catalytic effect of certain metals such as copper alloys, on oxidation as well as hardening of greases. When bearings with steel retainers are used most greases appear to be quite stable, but in the presence of bronze retainers, when subjected to the aforesaid conditions, some greases will become materially harder.

*H. A. McConville, Works Laboratory, General Electric Co., Schenectady, N. Y.

In Report on "Recent Developments in Evaluating Lubricating Greases" General Electric Review—p. 242-245 incl., May, 1937.



The SKF Angular Contact Bearing and High Speed Grease Test Units

Angular Bearing Grease Test

Unit A permits study of the behavior of grease in angular bearings. It consists of a horizontal shaft supported on each end by two angular contact bearings, resting in suitable pillow blocks. The shaft is belt-driven by a one horsepower 3,400 r.p.m. motor. The only load applied is that due to belt tension. In the right hand block, the test bearings are installed with their retainers diverging outwardly so that the grease tends to work out and away from the balls and races, while in the left hand pillow block the bearings are installed in the opposite direction so that the grease is worked into the races and voids. The former presents the most severe condition, hence is most valuable in denoting the lubricating ability of a grease.

Thirty grams of grease is charged to the lower half of each bearing, then the test is operated continuously until failure, or at least for a period of six months. Meanwhile, readings of bearing temperatures are taken every two hours. These temperatures, for normal operation, range from 120 to 130 degrees Fahr. for the bearings diverging outwardly, and from 140 to 150 degrees Fahr. for those diverging inwardly. Any sudden rise or sustained rise in temperature would indicate starved lubrication or bearing failure; when this occurs the test is discontinued.

At the conclusion of a successful test, the bearing elements are weighed to ascertain any loss in metal as compared with similar weights before assembly. This is taken as an indicator of wear. The grease on the bearing is weighed so as to have a measure of how it clings to the bearings. The amounts of grease in the housing and leakage are also determined. The grease itself is examined both chemically and physically for color change, oil separation, oxidation, etc.

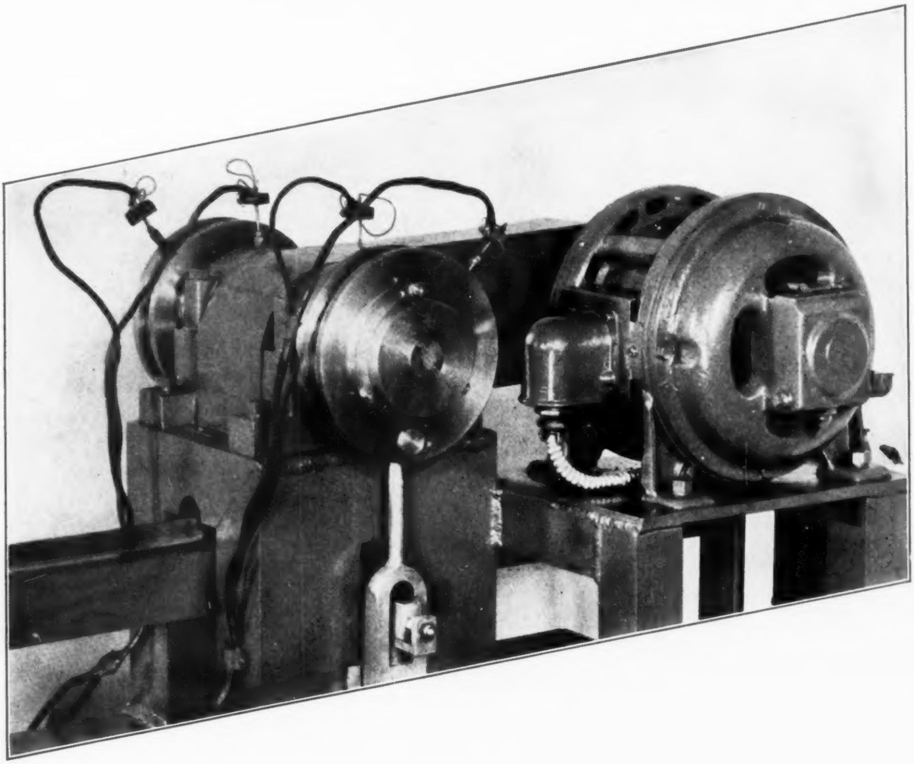
Horizontal High Speed Bearing Grease Test

Unit B is for testing grease in a horizontal high speed bearing. It consists of a horizontal shaft supported on each end by a ball bearing, held in pillow blocks by pins to prevent rotation of the outer race. The shaft is driven at a minimum of 11,000 r.p.m. through belt drive to a 3,500 r.p.m. one-half horsepower motor. Four grams of grease is charged into the bearing, then both seals are closed. Weights of the bearing and the bearing plus grease are taken before and after the test to determine loss of wei ht through wear, amount of grease retained on the bearing, and the amount of grease leakage. A test is continued until failure, or at least for six months, temperatures being taken every two hours. Any sudden and sustained rise is taken as indicating starved lubrication or bearing failure, and the test is discontinued.

Vertical High Speed Bearing Grease Test

Unit C is for vertical high speed testing; it permits of study as to how grease should be applied to a vertical bearing. In design the test unit is similar to the horizontal one, the test procedure is likewise the same.

Temperature measurements on all three machines are taken by using thermocouples in contact with the outer races of the bearings.



The SKF Heavy Load Cylindrical Roller Bearing Test Machine

This machine is intended for developing data as to the ability of a grease to stand heavy loads. It consists of a horizontal shaft supported by two cylindrical bearings, each spaced four and one-quarter inches from the center of the shaft, and resting in special pillow blocks. The journal extends through these two pillow blocks and is adapted to carry an additional bearing on each over-hanging end. These latter bearings are used as a medium through which the load is applied to the two center cylindrical bearings. The shaft is rotated at 2,100 R.P.M. by belting to a five horsepower 1,750 R.P.M. motor.

Seventy-five grams of grease is charged to each test bearing, the motor is started and run for one-half hour, at which time the load is gradually applied until it reaches the desired 4,240 pounds per bearing. This test is also run until the grease fails, or at least for six months. Temperatures are taken every two hours. At the end of the run, the bearing is studied for loss of weight and grease disposition. The grease is further examined both physically and chemically for oil separation, hardening, oxidation, etc. (The two outside bearings are charged with grease and carefully examined after each test. They are, however, not considered part of the test.)

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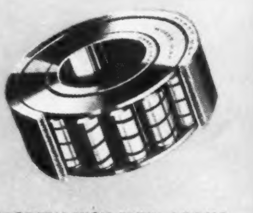
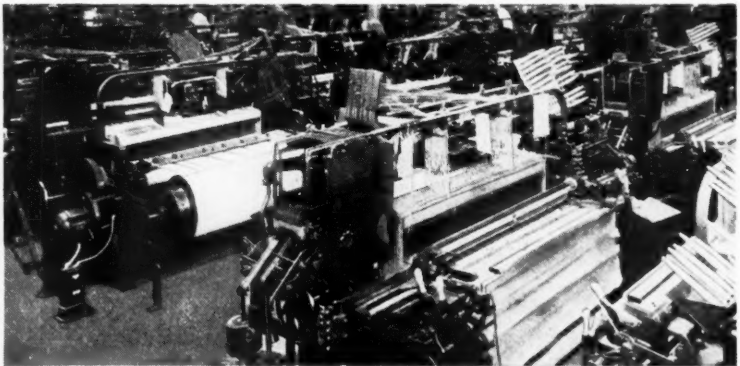
Ball and Roller Bearings at their POWER-SAVING BEST



MODERN HIGH SPEED LOOMS (right) equipped with anti-friction bearings. Present-day equipment in nearly every industry is saving power, giving smoother performance with correctly applied ball and roller bearings, lubricated with Texaco Starfak Grease.

Photo courtesy of Hyatt Bearings Division, G. M. Sales Corp.



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